FRACTURES OF THE HEAD AND NECK OF THE RADIUS.

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THAT fractures of the head and neck of the radius occur occasionally has been demonstrated positively by dissection, but that they are more than surgical curiosities will probably be disputed by many. Skiagraphic evidence collected by the writer[1] tends to show that they deserve a place among the common fractures.

It is remarkable that so important a fracture should have escaped the attention of the profession until 1834, when Berard[2] discovered the first reported case, at autopsy, almost by accident. In 1880 Bruns[3] could collect only 21 cases from the literature, 20 of which had been proven by anatomical investigation, and in 1905[4] the writer could find only 48. In skiagraphic collections in Philadelphia 55 more were discovered.

The essential facts concerning vertical fracture of the head, to which the writer has called attention, may be briefly summarized as follows: The approximation of the fragments may be so close that the skiagraph may fail to show the line of fracture, especially if the rays are directed in an incorrect plane. It is always intracapsular, and frequently fails to give crepitus or deformity, the fragments moving together as one piece within the closely fitting orbicular ligament. In a fall on the hand with the elbow extended only the anterior part of the radial head is in contact with the humeral condyle, and when the head is fractured it is this part which is broken off. Since the forearm is almost always in pronation in a fall forward on the hand, and since most falls on the hand are forward, the same part of the head is broken off in most cases. Although the X-ray, when available, should always be employed, the diagnosis in an uncomplicated case may be made by the symptoms. A history of a fall on the hand is important. The resulting swelling will not be commensurate with the degree of pain and impairment of function, and will be most marked on the outer side of the elbow. Exclusion of fracture of the humerus, ulna, and shaft of the radius, will be possible without great difficulty. There will, however, be severe pain and tenderness localized to the head of the radius, and limitation of all the movements of the elbow will be evident, more particularly of pronation and supination. Crepitus when present is not marked. Ankylosis of all the movements of the elbow, more or less marked, during the first month or two following the fracture, is almost pathognomonic.

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[1] University Medical Bulletin, September and October, 1905.

[2] Diction. de Med., 1835, en 30, vol. t. lx, p. 228.

[3] Centralblatt f. Chirurgie, 1880, vol. vii, p. 353.

Dr. Henry K. Pancoast, skiagrapher to the Hospital of the University of Pennsylvania, has kindly placed at the disposal of the writer his collection of skiagraphs of this fracture. Because of the absence of histories in most of the cases, and the obscurities necessarily associated with the skiagraphs, positive conclusions are reached with some difficulty. The greatest difficulties arise from the close approximation of the fragments and the fact that the fragments moving together as one piece within the orbicular ligament, it is exceedingly difficult to determine with anything like accuracy in what direction the line of fracture runs. It is thus evident that in directing the rays for the exposure of the fracture there is considerable risk that no fracture will be shown by the skiagraph. The skiagraphs which illustrate this paper will, however, emphasize forcibly some important points, *e.g.*, the close approximation of the fragments, and the absence of deformity. We have only to imagine the closely fitting orbicular ligament in position to obtain a sufficient explanation for these conditions, and for the frequent absence of crepitus. The writer would call particular attention to the relative frequency with which the faint line of fracture is shown by a lateral exposure of the elbow to the X-ray, although it is more or less obscured by the coronoid process of the ulna. An effort will be made later to explain the advantages of this position.

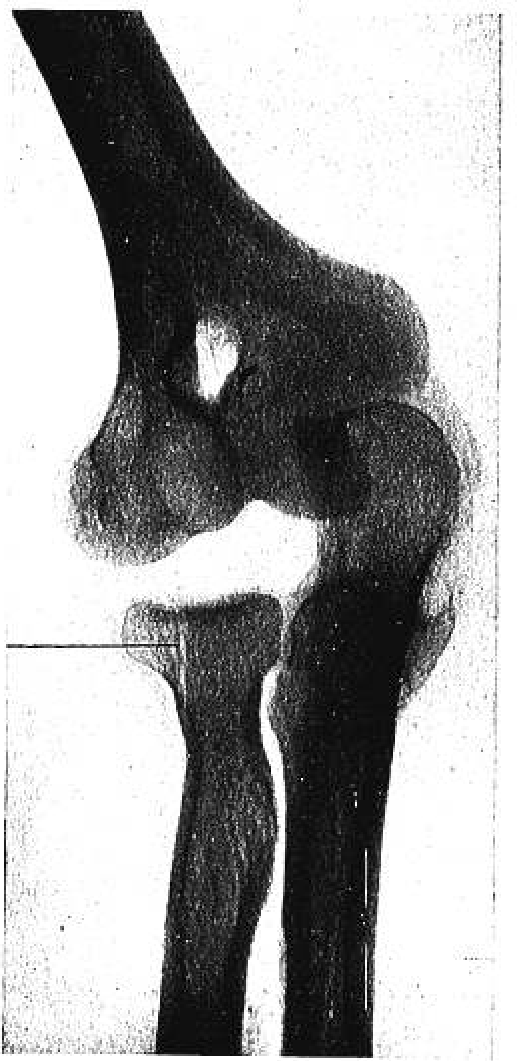
When the writer read his first paper on this subject before the State Medical Society of Pennsylvania in 1906, Dr. Pancoast reported that he had skiagraphs of 19 cases. Those for 23 are now available, while several more have been loaned to physicians who have not yet returned them. He considers that he has now about 30 in all. Of these 23, 11 may be positively included among the vertical fractures of the head. Five more are probably of the same type, 2 are injuries of the upper epiphysis of the radius, and 5 are fractures of the neck.

Of the 23, 10 are uncomplicated fractures of the head and 3 are uncomplicated fractures of the neck, while the two cases of epiphyseal injury are also uncomplicated. Four are complicated by posterior dislocations of the elbow, and one by an anterior dislocation of the radius. Two are complicated by transverse fractures of the humeral condyles. These figures corroborate to a marked degree the facts already shown by the literature.

In about 7 of the uncomplicated fractures of the head, so far as can be judged from the skiagraphs, the small detached fragment is anterior in the prone position of the forearm. In the 4 cases complicated by posterior dislocation of the elbow, the fragment is anterior and below its normal position. The writer concludes that it was driven downward by the impact of the condyle, when the forearm was in pronation, as in a fall on the hand.

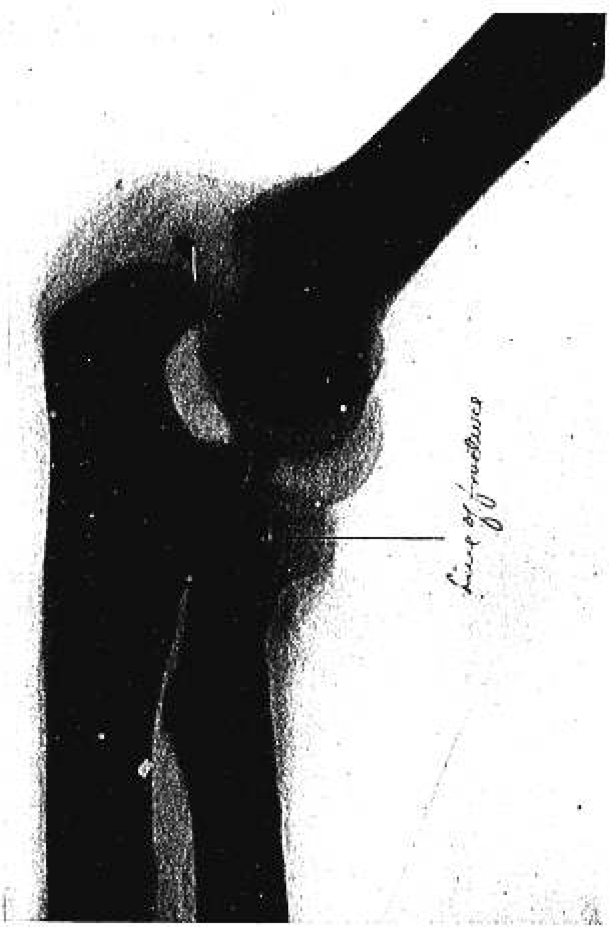
In order to emphasize more forcibly the difficulties in skiagraphy of the vertical fractures of the head, the writer has prepared two skiagraphs of an experimental fracture of this type (see Fig. 1 a and b). They will serve to call attention to the necessity for care in the interpretation of a doubtful skiagraph. The specimen represents a complete fracture separating the anterior third of the head, with the forearm in nearly full pronation, *i.e.*, in the position taken by it in the usual fall on the hand, which accident is probably responsible for most of the cases. For one skiagraph the forearm bones were placed

FIG. 1-A.



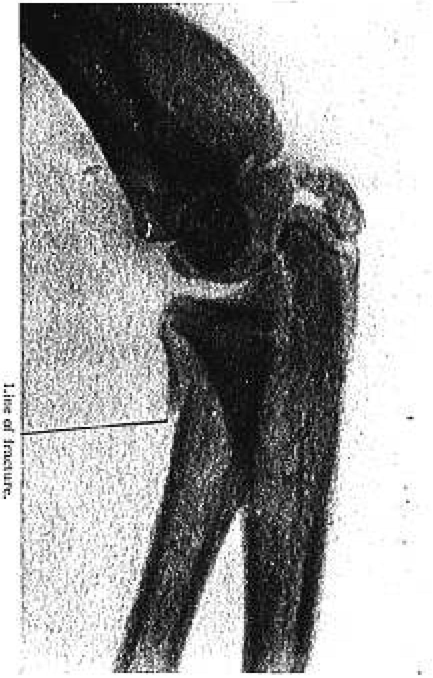
Vertical fracture of the head of the radius, experimental. Antero-posterier view. Forearm in nearly complete supination.

FIG. 1-B.



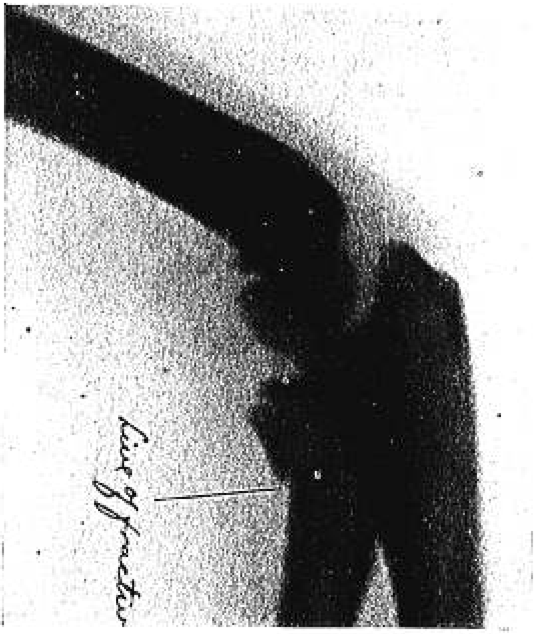
Vertical fracture of the head of the radius experimental—lateral view. Forearm in pronation.

FIG. 2.



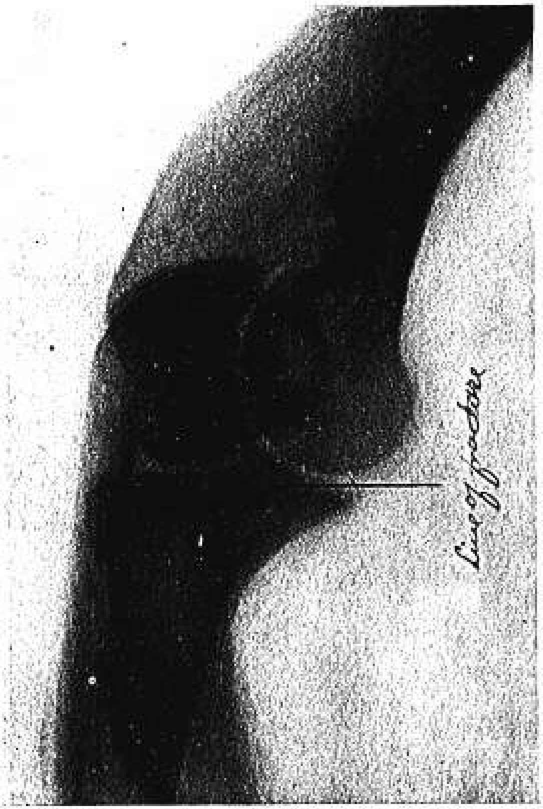
Vertical or oblique fracture of radial head in a young subject without injury of upper epiphysis. Lateral view.

FIG. 3.



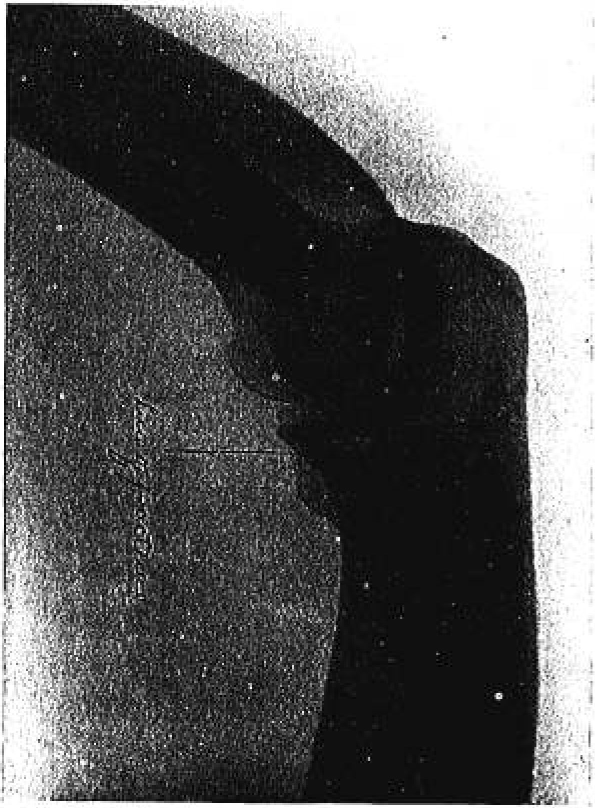
Vertical fracture of head of radius, without injury of upper epiphysis. Lateral view.

FIG. 4.



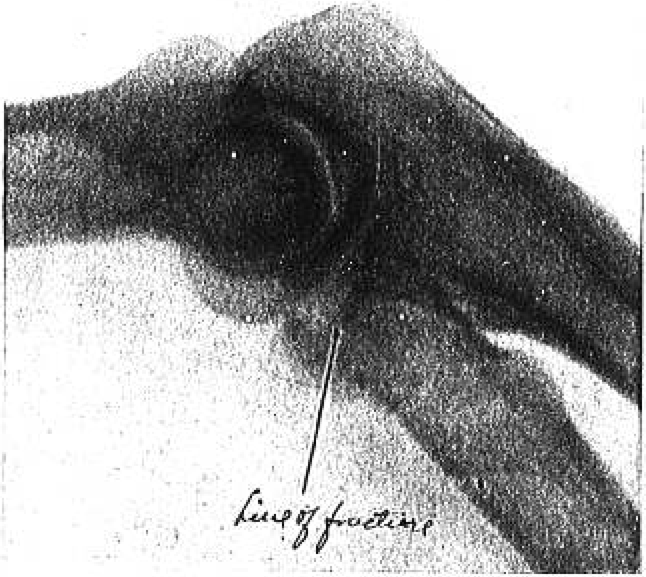
Vertical fracture of head of radius. Coronoid process of ulna obscures greater part of fracture. Lateral view.

FIG. 5.



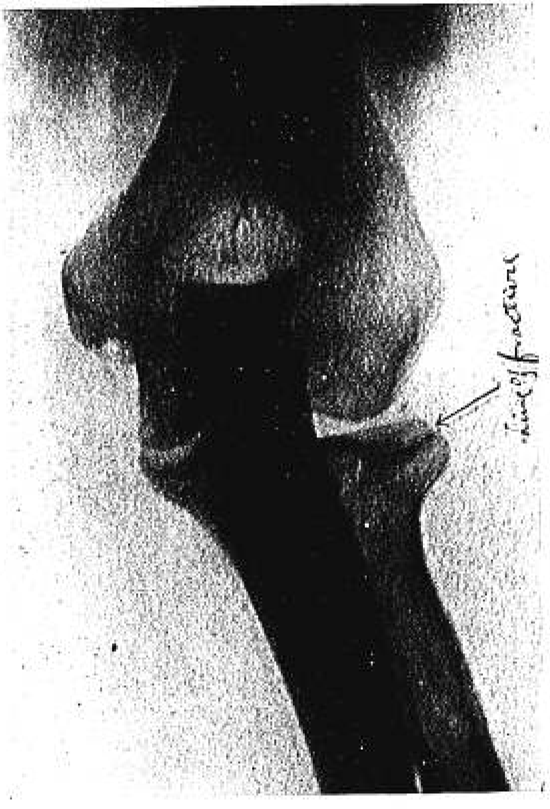
Vertical or oblique fracture of radial head. Lateral view.

FIG. 6.



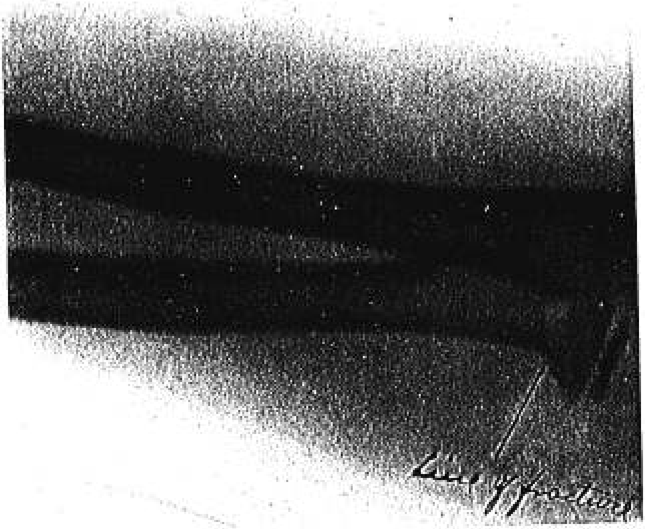
Uncomplicated fracture of radial head in adult.

FIG. 7.



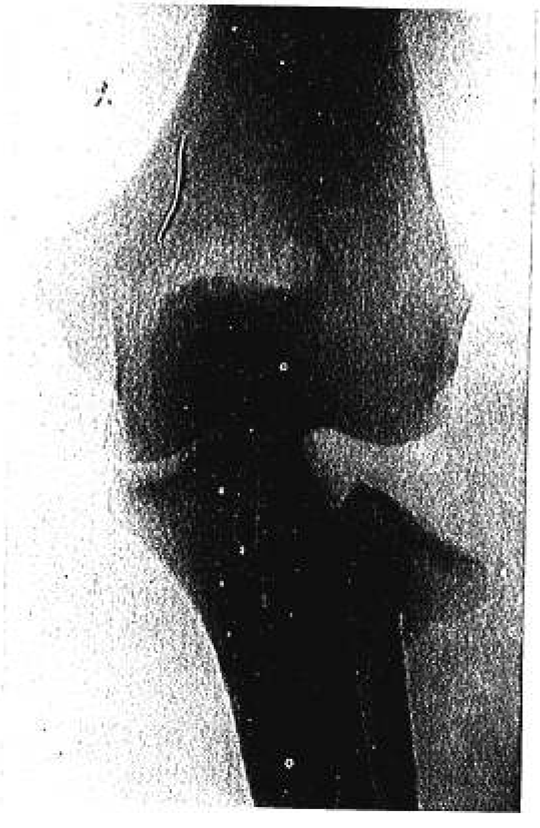
Uncomplicated vertical fracture of radial head in adult. Non-union.

FIG. 8.



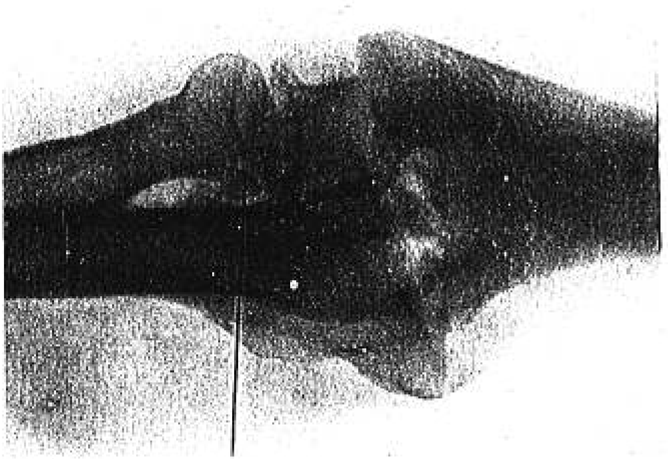
Transverse or oblique fracture of radial neck in young.

FIG. 9.



Fracture of neck of radius with typical deformity.

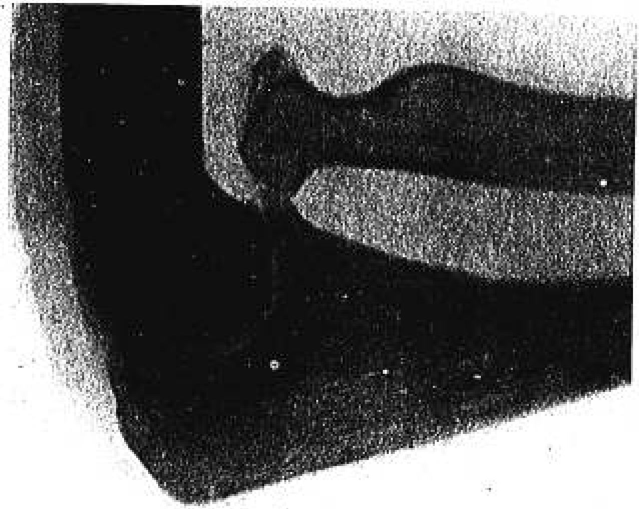
FIG. 10.



Line of fracture

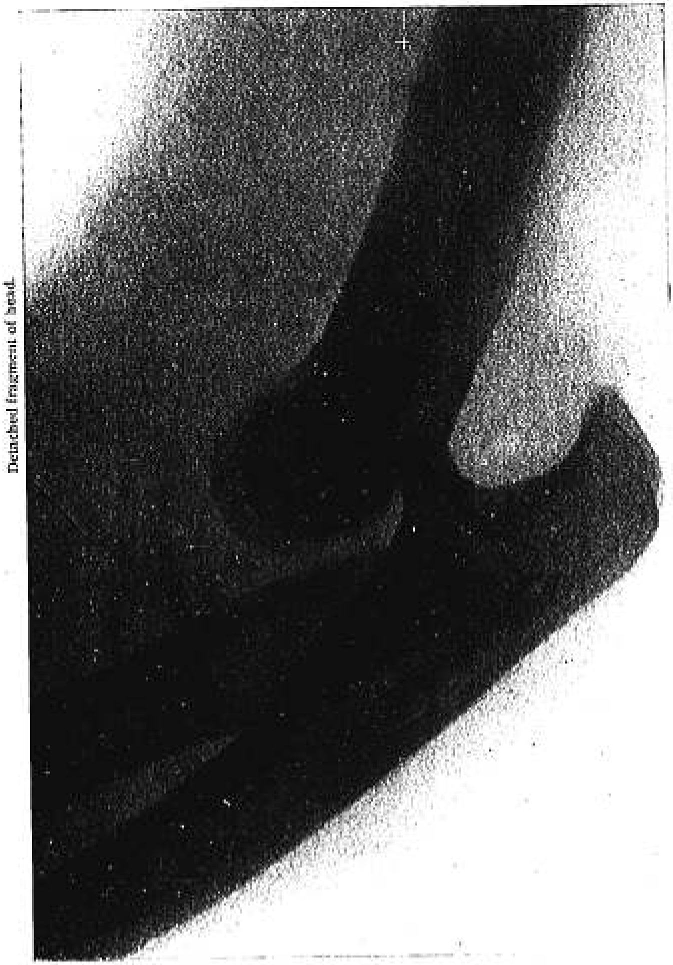
Fracture of head of radius complicated by fracture of humerus and olecranon.

FIG. 11.



Fracture of head with anterior luxation of the radius. Lateral view.

Fig. 12.



Fracture of head with post. luxation of elbow.

in the position of nearly full pronation, the detached fragment being then anterior, and the line of fracture passing transversely. A lateral view was then taken; that is, the rays were made to pass as nearly as possible in the line of fracture, this line being slightly angular. For the other skiagraph, the bones were so placed that the line of fracture passed as nearly as possible in an antero-posterior plane, *i.e.*, the bones were placed in a position about midway between full supination and the mid-prone position. An antero-posterior view was then taken. If the forearm were in full supination, the detached fragment would have occupied a postero-external position and the line of fracture would have passed obliquely from about the external surface of the head to the posterior surface, and would, therefore, have been in an unfavorable position for an antero-posterior or a lateral view.

In comparing these two skiagraphs with those occurring in the living, it should be borne in mind that all the soft tissues were removed from the specimen, the bones being cleaned by scraping and the ligaments by close dissection. The elbow joint had been opened freely, which explains the abnormal relations of the bones, but the orbicular ligament was in place and the fragments closely approximated, as they frequently are in life. In the living there will probably always be some slight movement of the limb, because of the flash and noise of the X-ray machine, so that the absence of movements in the specimen added to the clearness of these two skiagraphs. Moreover, the obscurities from over and under exposure have been well avoided. It is evident, therefore, that we have here two skiagraphs of this obscure fracture, made under the best possible circumstances. How much more obscure would such a fracture have been in the living, with all the tissues, now swollen, in place, the slight movements during the exposure to the X-ray, and the practical impossibility of knowing the exact direction of the line of fracture.

If the rays are directed at right angles to the line of fracture, the skiagraph will probably be negative in most cases. Is it possible to determine the direction of the line of fracture.

so that we may pass the rays directly through the line of fracture or nearly so? If the fracture is due to a fall forward on the hand, and most of them probably are, then we know that at the moment of impact the fragment is anterior, and that the forearm is in pronation; since in all positions of the forearm with the elbow in extension, only the anterior part of the radial head is in contact with the external condyle, and in a fall forward on the hand the forearm is in pronation. With the forearm in this position, therefore in a lateral exposure the rays should pass directly or almost directly in the line of fracture. In the writer's opinion this is the best view to obtain, in most cases. Because the direction of the rays will vary more or less in each case, sometimes the fracture shows above the coronoid process, sometimes below, or both, sometimes through it, and at other times in front of it. Another advantage in favor of this position is the fact that owing to the disturbance within the joint, the pain is so great that for some days at least no other position will be permitted by the patient.

If the forearm could be so placed that the detached fragment was exactly external, an antero-posterior exposure to the X-ray would give a skiagraph of the line of fracture not obscured by the coronoid process. One of the great difficulties, however, is in judging accurately the position of the forearm, when an attempt is made to supinate it. It should be borne in mind that the shoulder is responsible for a considerable degree of rotation and to what extent the shoulder and elbow are contributing in a particular case has not been easy to decide. The writer has seen only one case in which a satisfactory result was obtained with an external fragment, and that was in his first case, which was quite the result of chance, as nothing was then known of the mechanism of the fracture by the writer or the skiagrapher. On the other hand, he has repeatedly obtained a satisfactory exposure by a lateral view with the forearm in pronation.

Unfortunately all falls on the hand are not forward, and the hand is not always in pronation at the moment of impact. As it is always the anterior part of the head which will receive the brunt of the force from the external condyle, whatever the degree of rotation, it is evident that a different portion of the head will be involved at the moment of impact with each change in the degree of rotation. It is a fact, therefore, of the greatest importance that most falls are forward, when the hand is usually in pronation, since from that fact we know the positions of the fragment and the line of fracture.

In some cases it was observed that in the first week following the accident, after the acute symptoms had subsided, a considerable degree of rotation was possible. This is due to the close approximation of the fragments, and their inability to move on each other, the head moving as a whole within the orbicular ligament. The more perfect the approximation, the more quickly will rotation be permitted. It is probable, however, that only in very rare cases will complete supination be possible until some weeks after the fragments have united. In this type, the vertical fracture of the head, rotation is most disturbed at the time of the accident and for some weeks later, but it is more rapidly restored than is flexion and extension. While the acute symptoms at the time of fracture are distinctive of this injury, it is this persistent limitation of flexion and extension and less markedly of pronation and supination, for some weeks following union, that is most characteristic, in the absence of crepitus or a skiagraph showing a line of fracture. When there is wide separation of the fragments or the neck is broken, the skiagraph will have little difficulty in disclosing the fracture. Much care will be necessary in the taking and the interpretation of the skiagraph, in the ordinary vertical fracture of the head, and due attention must be given to the symptoms, if overlooking this frequent and important fracture is to be avoided.

The following case occurring in the practice of Dr. H. A. Smith, of Philadelphia, illustrates a condition in which the skiagraph will be of no avail, however carefully and skilfully it is taken:

A boy, 6 years old, fell from a height of three steps on his left side, without knowing what part of his body struck the ground. When he was brought into the house his mother says that the affected arm hung helpless at his side and that the pain was very severe. He could not then move the elbow. When Dr. Smith saw him some hours later, there was considerable swelling on the outer side of the elbow. Palpation of the condyles of the humerus, the whole of the ulna and the shaft of the radius, did not reveal a point of tenderness or pain. But directly over the head of the radius the pain and tenderness were very severe, both on direct pressure and any attempt to move the forearm. Dr. Smith made the diagnosis of fracture of the head of the radius. At the doctor's request the writer examined the patient and reached the same conclusion. Since ossification in the radial head does not begin until the fifth year, the skiagraph did not promise help in establishing this diagnosis. Two skiagraphs, however were tried, one giving a lateral and the other an antero-posterior view. No shadow of the head was obtained in either. In such a case, if the diagnosis is to be made, it must depend on the symptoms; and in this case they were typical at this stage. Twenty-four days later the writer examined the patient for the characteristic limitation and found it distinct and typical. The early marked limitation of rotation had disappeared almost entirely, but the flexion and extension, as is also usual, were more distinctly limited, both to about ten degrees of the normal. There was now no pain on movement, and the patient could lift an ordinary kitchen chair with both hands, the affected arm apparently doing as much work as the right. Every sign of fracture of the head, therefore, peculiar to those cases in which the skiagraph had shown positive fracture, was present in this case, and in the writer's opinion pointed to a positive fracture of the cartilaginous head.

A case, somewhat similar to the preceding, occurred in the practice of Dr. W. Drummond of Philadelphia, in a man about middle life. It was the writer's privilege to examine this case also. There was a distinct history of a heavy fall on the hand from a wagon. Every symptom pointed to a severe injury of the radial head and of no other bone, while the later history showed the typical limitation of movement for some weeks after union. The skiagraph showed only the slightest sign of fracture on the under surface of the head, although this was distinct. If the skiagraph were absolutely negative, the writer would still make a positive diagnosis of fracture of the head as in the previous case.

In most cases of this type union occurs in about 4 weeks and the limitation of movement rapidly disappears in a few weeks following the removal of the dressings. This was so in cases seen by Drs. A. C. Wood, W. Drummond, H. A. Smith, E. Y. Rich, of Philadelphia, and A. B. Donaldson, of Bala, Pa. In two cases already reported by the writer, union occurred in the usual time in one, while in the other during rough manipulations by the masseur a refracture occurred, showing that the union was probably fibrous. In both the return of function was equally rapid and complete, although in the latter slight crepitus shows that non-union is still present.

The writer succeeded in following up two of Dr. Pancoast's cases. In connection with one the mother of the boy said that the patient failed to return for dressings after the first visit. The original dressing was kept in place for a week or two and was then taken off, the mother thinking the injury trivial. Full function returned. In the other case the fracture occurred about 10 months ago. When the writer found him recently, the patient had become very much discouraged, and he was contemplating giving up his usual occupation to take up lighter work. There is a constant annoying pain in the elbow, and when using the limb vigorously at his work the pain is transferred down the forearm (probably from pressure on the posterior interosseus nerve, which winds closely around the head and neck of the radius). Occasionally there is pain in the wrist and at rare intervals the pain in the elbow is very severe. Extension could be carried only to about 30 or 35 degrees of the normal. Limitation of rotation was slight and almost inappreciable. It is worthy of note that at the time of the fracture, 10 months ago, slight but distinct crepitus was elicited, showing that there was some movement between the fragments. The skiagraph now shows an ununited fracture.

If these fractures of the upper end of the radius have been common, then it would be interesting to know how many or what percentage leave permanent disturbances, as in the preceding case. Again the question naturally arises as to whether an injury so obscure at the time of its occurrence will give signs long afterward sufficient to warrant a diagnosis of fracture of the head or neck of the radius. The writer has a skiagraph of a fracture of the neck of the radius, taken about 15 months after the accident, when no external signs were present pointing to the original injury, except a slight limitation of rotation. Yet that skiagraph permits no doubt as to the nature of the original injury. What signs should an old fracture of the head or neck present? Since writing his first paper on this subject, the writer has been anxious to find cases of this kind.

The first to arouse his suspicion was in an old acquaintance. He had no pain, but as long as he could remember he had been unable to rotate his forearm. On examination it was found that flexion and extension were free and full, but there was complete inability to rotate the forearm, indicating a probable bony union between the radius and ulna, in some part. The palm of the hand was always turned downward, *i.e.*, the forearm was fixed in the position of pronation, the position in which fractures of the head and neck usually occur. No deformity could be detected in either the radius or ulna, such as would tend to show the seat of an old fracture. He had never had any bone or joint disease. He had heard his parents, now dead, say that he had sustained a severe fall in early childhood, which produced a severe injury of the arm, but its nature had never been understood. He called the writer's attention to a peculiar movement at the wrist. Although he could not supinate the forearm in the least, he could by strong effort turn the hand in the direction of extreme pronation so that the palm looked upward. He further called attention to a peculiar deficiency in the lower end of the ulna, which the writer could not explain, but was inclined to consider as a gradual disappearance of bony obstruction to the repeated efforts that he had probably made, during many years, to turn the hand in the direction of extreme pronation, in his attempts to compensate for the loss of supination in the forearm.

It is evident that such complete ankylosis of rotation as exists in this case, following a severe injury, with no history or evidence of bone or joint disease, must have been caused by a fracture. A fracture at the lower end of the radius or ulna or both, which would leave such a result, would almost certainly have been recognized at the time of the accident or later. A fracture of the shafts of the forearm bones to produce so much disturbance of rotation would probably have resulted in union of both bones across the interosseous space, and that could hardly have escaped detection. A fracture of the condyles of the humerus or of the olecranon would probably have been recognized at the time, and if ankylosis followed, flexion and extension would have been most markedly disturbed, whereas in this case they are not at all disturbed. In the writer's opinion, only a fracture of the head or neck of the radius or both would have so limited rotation alone, and at the same time have been so obscure as to escape the attention of the physician. Owing to the fact that the patient lives in a distant city, the writer has so far failed to obtain a skiagraph of this patient's elbow. The fact that the forearm is fixed in pronation is significant, since we know that most of these fractures result from a fall on the hand with the forearm in pronation. It is probable that the head or neck of the radius, or both, were severely injured, and that immediately following the accident he could not rotate the forearm because of the pain, and later because of the change in the shape of the head of the radius, or its union with the ulna.

While the writer was treating a patient for a sprain of the knee, his attention was called to an obscure injury of the elbow, which the patient had received about twenty-five years before, and which had left him with limitation of rotation ever since. The diagnosis had never been made. He had fallen from a horse on his hands and had injured his elbow severely. He experiences very little trouble now, but notices that during boxing exercises, in which he indulges frequently for pastime, there is one blow he avoids because his thumb is in the way and is unduly punished. On examination the writer found that pronation was complete, but that supination was not quite complete, and that it was owing to this incomplete supination that his thumb suffered during boxing. Flexion and extension showed nothing abnormal. Suspecting an old fracture of the head of the radius, a skiagraph was taken and that part of the head broken off in the usual fracture, showed in the opinion of the writer, slight evidence of an old fracture which had united leaving too little evidence of deformity to be positively recognized by the skigraph.

In a third case the skiagraph was more positive. A medical student informed the writer that at his boarding house was an old man, who had asked to have his forearm examined. The student could not make a diagnosis, and after stating the circumstances of the case, asked the writer for a suggestion as to the cause of the trouble. Suspecting a fracture of the head or neck of the radius, the patient was brought to the University Hospital, when Dr. Pancoast took two skiagraphs of the elbow, one a lateral view with the forearm in pronation and the other an antero-posterior view with the forearm about midway between full supination and the mid-prone position. The latter was the more satisfactory, and a corresponding view of the opposite elbow was taken, for comparison. (See Fig. 13—a and b.)

The patient is a man, 64 years of age. About 50 years ago he injured his forearm, he thinks by a wrench while at play with another boy. Although his memory is very vague as to the exact circumstances, he thinks that it was while his arm was still in a sling that he fell a considerable height from a beam in a partly constructed new building. This fall could easily have produced a fracture of the head or neck of the radius. All that he is certain of now is that he has not been able since to properly rotate his forearm. Flexion and extension are free and complete. The condition has considerably disabled him as a carpenter. He has never known the nature of the injury, the diagnosis never having been made. The skiagraph shows clearly, in the writer's opinion, that the radial head has been fractured, and that the deformity shown is sufficient to account for the limitation of rotation.

In fractures of the neck, which, unlike those involving the head, are transverse or nearly so, impaction is relatively common. That part of the head which is detached in fractures of the head, only, is driven downward and forward by the impact of the humerus, so that the head forms an angle with the shaft. Pratt,[5] who wrote at some length on this subject, did not say anything of impaction, but observed that there was a displacement of the upper fragment, which it was difficult or impossible to reduce. He advised excision of the head in these

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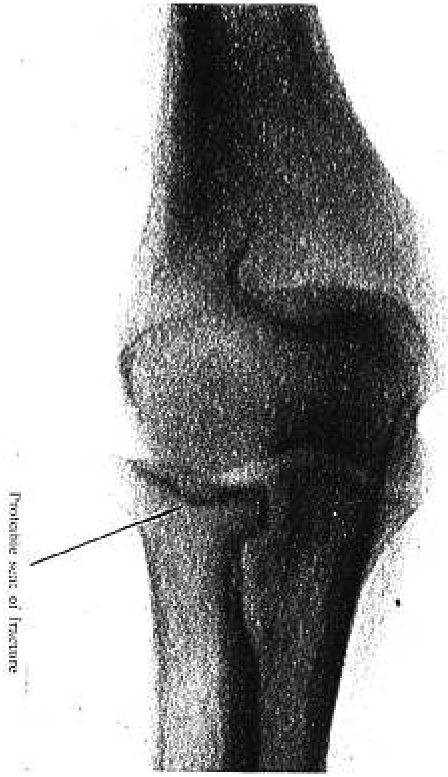
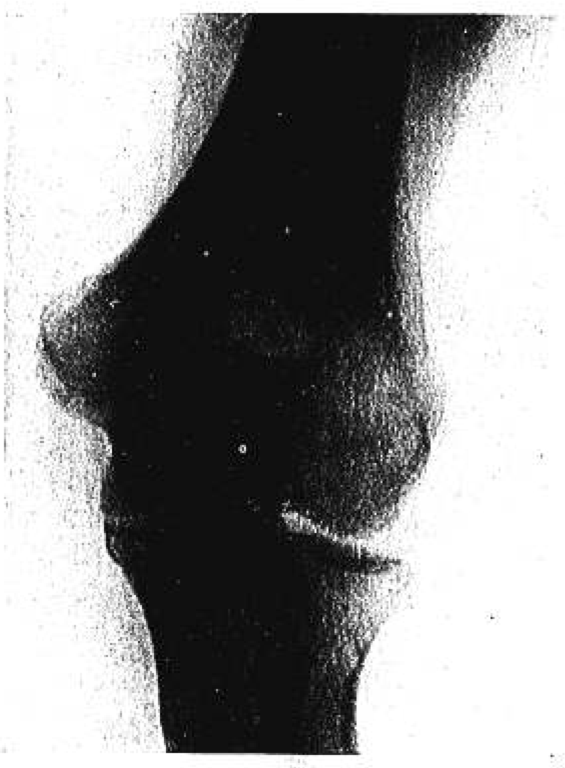
[5] Revue d'Orthopedic, March, 1906.

FIG. 13A.



Old fracture 50 years ago.

FIG. 13-B.



Normal elbow, the uninjured side for comparison, with Fig. 11-A.

cases. He observed also that crepitus was sometimes absent, and accounted for it by assuming that owing to the pull of the biceps muscle on the lower fragment, the fragments were not in contact with each other. From the histories of two cases and from the skiagraphs of these two and a third case, the writer is inclined to believe that impaction is frequent in uncomplicated fractures of the neck. Three of the four cases in this group seem to show it. The impaction would account for the difficulty in reducing the displacement and for the absence of crepitus which Pratt observed. We know that impaction is common in fractures of the lower end of this bone. The same cause, a fall on the hand, will explain its presence in both fractures. While theoretically the biceps might pull the fractured surfaces of the lower fragment out of contact with that of the upper, as Pratt says, the writer cannot find any evidence of it in any of these skiagraphs. The writer has already referred to a specimen of this fracture in the Mutter Museum of Philadelphia, showing the typical deformity which Mutter accounted for by the pull of the biceps. The deformity in that specimen corresponds in a marked degree with the deformity shown in all three of the probably impacted fractures of the neck in this group. Much attention was given to this by the writer in his first paper. The angulation in the neck is probably due to the downward impact of the external condyle against the anterior part of the head of the radius, which is driven downward and forward, producing the angle in the neck. Even if the pull of the biceps was responsible for the deformity in the museum specimen, as Mutter says, it was not instrumental in separating the fractured surfaces from each other. Pratt also says that usually the greatest prominence of the upper fragment was posterior and external. This statement has very little meaning, since it does not give the position of the forearm. When the fracture is due to a fall on the hand in the prone condition, the greatest prominence of the head will be anterior in pronation, and by partial supination will be placed in an external position. If full supination could be produced it would occupy a postero-external position.